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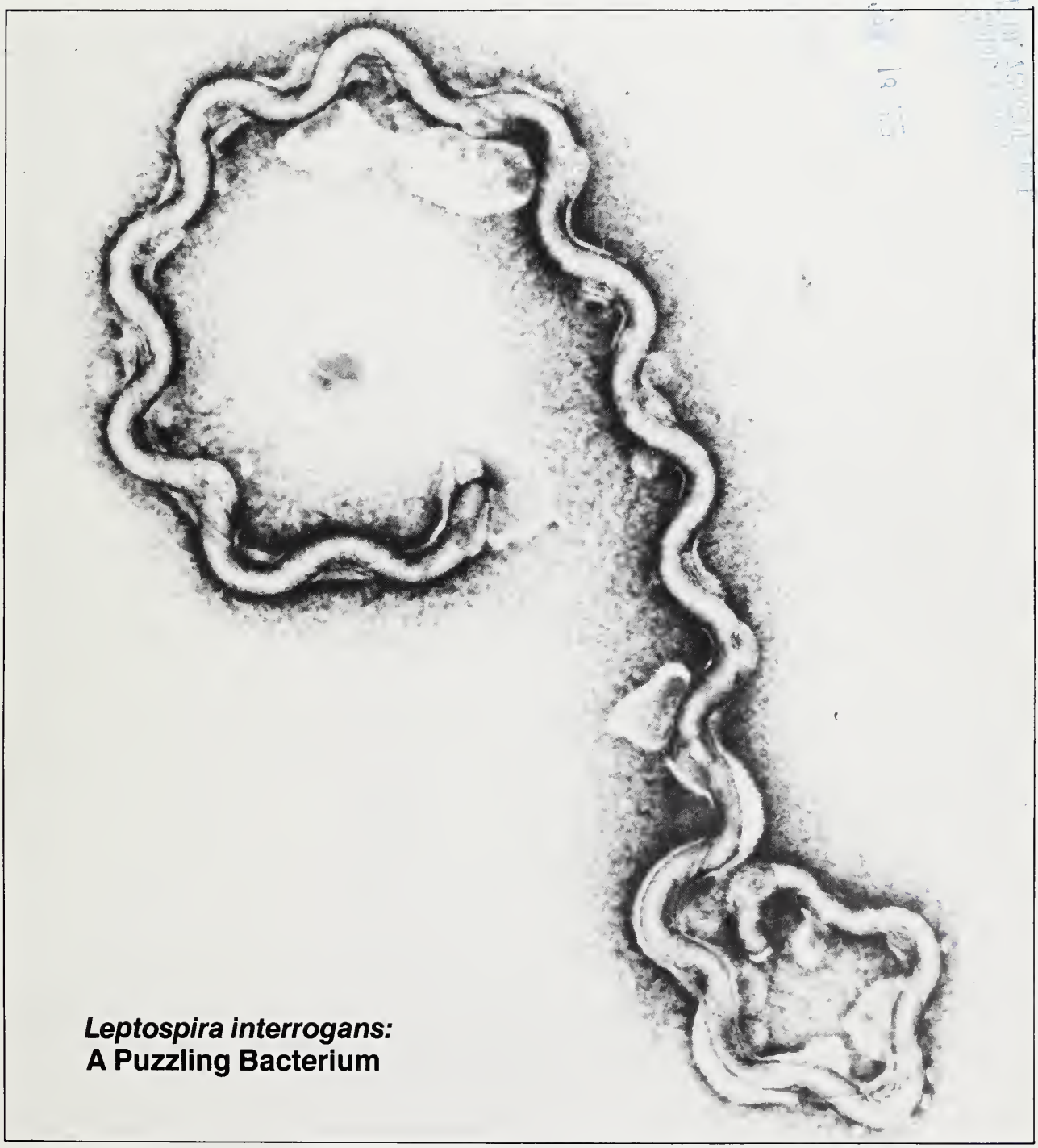
Agricultural Research



Leptospira interrogans:
A Puzzling Bacterium

Disseminating Research Findings: An ARS Priority

A blueprint for speeding delivery of research discoveries to farms, industry, and the public is being initiated by the Agricultural Research Service.

According to Orville Bentley, assistant secretary for science and education at the U.S. Department of Agriculture, a new coordinator's office, weekly reports via computers, and other actions are being taken to expand and strengthen the transfer of agency technology to users.

"Discoveries written up in scientific papers alone do not save soil, boost crop yields, or bring forth new or better products," Bentley says. "Benefits from scientific discoveries are generated only after the technology has been passed on to users—farmers, industry, and consumers."

Bentley says the new plan for technology transfer is a "significant step as ARS redirects resources to answer the nation's need for federal research."

The return on public investment in agency research is conservatively estimated in billions of dollars a year. The combined return from just three technologies—irrigation scheduling, Marek's disease vaccine for poultry, and chemical growth regulators of fruit trees—is estimated at $263 million a year.

In putting the technology transfer plan together, the agency surveyed its scientists who last year made over 61,000 contacts with key users of agency research findings. These users include farmers and ranchers, agriculture-related industries, consumers, federal action agencies such as USDA's Soil Conservation Service and Animal and Plant Health Inspection Service, and state and local governments.

When fully operational next year, the plan also will provide the agency with additional feedback on research needs of the different users.

A newly appointed national technology transfer coordinator will assist the research agency's Office of Research and Technology Applications in monitoring and transferring the technology as it is developed throughout the agency.

A key element in the plan is a new nationwide computer network. Scientific results reported in professional journals by 2,800 agency researchers at 140 locations will be electronically collected and stored.

Interpretive summaries of journal articles will be written for the computer system by agency scientists and engineers. More than 3,000 articles are submitted to journals each year.

In turn, USDA's Extension Service will transmit the research information to computer terminals at land-grant universities and on to users in all 50 states.

Other steps taken to improve the transfer of technology, Bentley says, will include involving users and potential users in planning and evaluating research, conducting joint research, and stimulating commercial adoption of research-based patents.

A new emphasis also will be given to agency participation in the Federal Laboratory Consortium, which was established by the Stevenson-Wydler Technology Innovation Act of 1980. Fifteen of the research agency's laboratories around the country have been selected to be major data suppliers to the consortium.

Examples of technology successfully transferred to key users in recent years include:

- Export technologies for shipping that opened a multimillion dollar market in Europe for U.S. watermelons, lettuce, grapefruit, and kiwi fruit.
- Methods of diagnosing, controlling and reclaiming saline seeps in the U.S. Northern Great Plains that could prevent losses of $120 million a year in farm income.
- Near-infrared reflectance technology for rapid evaluation of moisture and protein content of grains and oilseeds.
- Durable flame-retardent treatments for all-cotton fabrics, accounting for about 8 million yards of fabric annually.
- Automated systems for handling live poultry, saving the industry up to $14 million annually.

Coming soon to *Agricultural Research* —

Starting with the July/August 1984 issue, Agricultural Research *will carry a new department:* ***PATENTS.***

The U.S. Department of Agriculture has more than 1,200 patented inventions that are available for license, which are the result of ARS research. Many of the patents have commercial application. Farming equipment, food preservation and processing technology, textile treatments, and new uses for oils, starches, microorganisms, fungi, and pharmaceuticals are just some of the areas covered by these inventions.

***PATENTS** will carry short descriptions of several patented research or technology inventions, and suggest what types of businesses might be most interested in using them. It will tell you whom to contact for further technical information and where to write for information on obtaining a patent license.*

*Watch for **PATENTS** on the back page of the July/August issue of the magazine.*

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Cover: An electron micrograph depicts *Leptospira interrogans, a* spiral bacterium that causes leptospirosis, the most widespread of all diseases exchanged among man and animals. Scientists at the National Animal Disease Center are seeking improved techniques for identifying uncommon leptospires—while characterizing components that will lead to better vaccines. Story begins on p. 4. (PN-7097)

Correction: Several readers have called to our attention that the aphids on a wheat leaf (photo 1183X1636-14A) appearing in our February issue, page 11, were incorrectly identified as *Rhopalosiphum padi.* The aphids are *Macrosiphum (Sitobion) avenae* (Fabricius). We regret this error.

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Research on the complex interactions of drugs and trace minerals may give us clues for healthier diets.

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The disease, leptospirosis, is caused by a bacterium that continues to challenge scientists after years of research.

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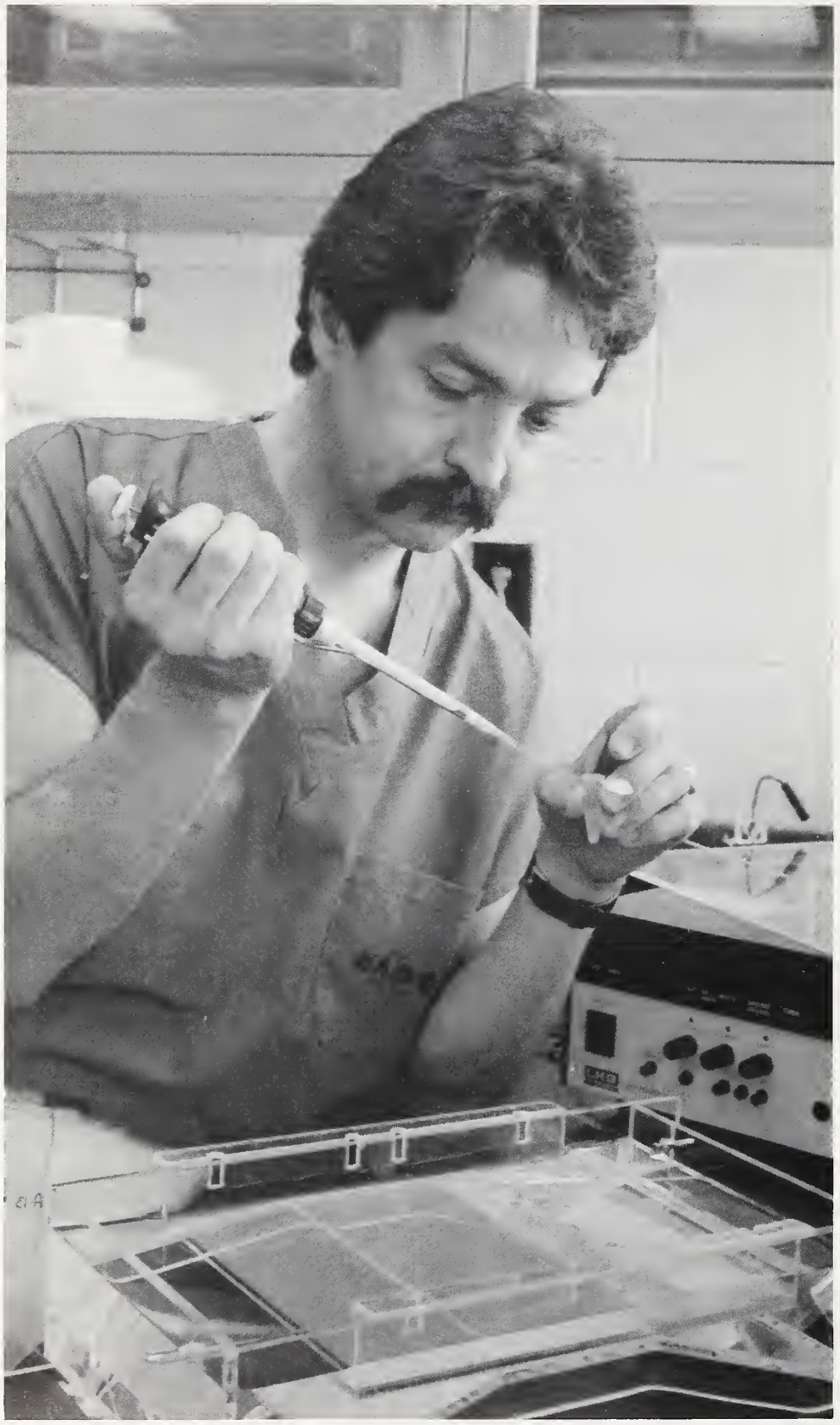
Leptospirosis: For Every Answer, a New Question



Veterinarian Alejandro B. Thiermann prepares to perform a laboratory test in his leptospirosis research at the National Animal Disease Center. (0584X534-11A)

A thin spiral question mark challenges scientists studying the nest of look-alike agents that cause leptospirosis—the most widespread of all diseases exchanged among man and animals.

Discovered in 1915 and later named for its appearance, "a spiral shaped like a question mark," *Leptospira interrogans* lives up to its name with a continuing spiral of questions and misleading clues. Every answer gleaned in more than 20 years of research at the National Animal Disease Center has the question mark behind it, says Alejandro B. Thiermann, research leader.

This spiral bacterium is one species, but it includes more than 150 look-alike pathogens. Infection by one does not produce immunity to another.

Each can infect any mammal in the world. Most, however, adapt to a preferred host. They infect opportune hosts when the environment permits.

They hide in hosts. A pathogen may cause no obvious symptoms in a preferred host, especially rats, but cause severe symptoms and death in an opportune host—man, for example.

They hide behind each other. The presence of one can conceal others.

They hide behind other pathogens. They cause symptoms that resemble or duplicate symptoms caused by viruses or other bacteria.

They hide behind nonpathogens. Nonpathogenic leptospires that look like the pathogens can contaminate laboratory materials and cause false diagnoses.

Each leptospire, a single long cell, contains two rigid filaments intertwined in a spiral. The cell twists, turns, rotates, and undulates in a variety of shapes including the question mark. The ability to bore through viscous fluids, mucosal surfaces, and spaces in cells may help leptospires infect animal and human hosts, suggests Herman C. Ellinghausen, Jr., retired center microbiologist.

Invading blood, liver, kidneys, lungs, brain, spine, and other organs, leptospires can cause the fever, headache, muscle pain, vomiting, and constipation or diarrhea, called "flu," or more severe syptoms. "Leptospirosis occurs in mild or severe forms and is easily

misdiagnosed," says Thiermann. It can be confused, for example, with hepatitis, yellow fever, pneumonia, polio, meningitis, encephalitis, and other human infections. It ranks second to salmonellosis among the diseases transmitted to man from animals as a cause of human death in the United States. The fatality rate among patients with severe symptoms is about 30 percent.

Leptospirosis is common and economically important in livestock all over the world, Thiermann says. Blood serum tests indicate it occurs in about 8 percent of the world swine population and 15 percent of the cattle.

"Theoretically, any pathogenic leptospire (called a serotype) is capable of infecting any mammal," Thiermann says. "Practically, only a few serotypes are present in any region, and each serotype appears to adapt to a few preferred hosts but still can infect other species." The serotype icterohaemorrhagiae for example, adapts to the rat as the preferred host, but it also infects other species including humans.

The organisms spread by direct contact among infected and uninfected animals and humans, and in water and soil polluted by urine from infected hosts. Urine is toxic to leptospires, but Ellinghausen points out that it can be diluted in the environment, especially in water, before the organisms die.

Leptospires have been isolated from dogs, horses, swine, cattle, sheep, goats, and more than 20 species of wild animals, including birds, reptiles, amphibians, arthropods, and marsupials. They cause abortions, stillbirths, infertility, reduced milk and meat production, mastitis, meningitis, or other less specific symptoms in animals.

"They are being recognized more frequently as a cause of encephalitis," Thiermann says. "In one cattle study, we found 51 brain isolations as opposed to 52 kidney isolations and only 6 from blood. Other investigators found leptospires in sewer rat brains although the kidneys were culturally negative." Leptospires are commonly associated with the kidneys.

Common diagnostic procedures concentrate on finding antibodies to leptospires in a sick animal's blood serum, but these serological studies can give misleading results. The first step in cutting off the spiral of questions, Thiermann says, is isolating the agents—ferreting them out of hiding. Finding antibodies in an animal's blood serum establishes that the animal is reacting to an antigen produced by a specific agent but does not establish that the agent is present now.

Each serotype has some antigens unique to it and some shared with other leptospires, Thiermann explains. Antigens cause an animal to produce antibodies. Antibodies are specific. Each gives some protection against a specific serotype, and each reacts with a specific antigen, causing, for example, clumping or agglutinating. Scientists use the agglutination reaction in common diagnoses to identify serum antibodies that agglutinate specific serotypes of leptospires.

Thiermann points out, however, that a vaccinated animal will have antibodies when it does not have leptospirosis. "The most widely used test, microscopic agglutination, furthermore, does not give consistent results among laboratories," he says. It is common, for example, to isolate leptospires from test-negative cattle.

A recent report on serological diagnosis of human leptospirosis in Panama is another example. Thiermann says 70 percent of the cases could be diagnosed "only when leptospires isolated there were used as the antigen in the microscopic agglutination test.

"Serological methods in general are of restricted value," he emphasizes, "if they are not used in conjunction with isolation of the agent." Isolating an agent relates it to a specific host, makes it available for the tests and for determining its potency. Pathogenicity can vary even within each of the more than 150 look-alike serotypes.

National Leptospirosis Reference Center Established

ARS and USDA's Animal and Plant Health Inspection Service have established a National Leptospirosis Reference Center in Ames, Iowa, to fight this elusive disease that costs the livestock industry more than $50 million annually. Research at the center should lead to faster and more accurate diagnosis of leptospirosis and the development of better vaccines and drugs to prevent and treat it.

According to Terry B. Kinney, Jr., ARS administrator, $250,000 of existing funds will be refocused to emphasize fundamental research in support of the new center.

"This approach should provide the backup knowledge and improved technology our animal and plant health agency colleagues need for more effective diagnosis as well as better methods for the control and prevention of the disease on farms and ranches," Kinney says.

ARS will have four main responsibilities in the joint effort. They are: devise better ways to isolate and identify unusual strains of the disease, determine the pathogenicity of new strains, identify components in them that may impart immunity to the disease, and develop and improve diagnostic techniques.

Bert W. Hawkins, APHIS administrator, says the joint effort is an important step toward curbing losses inflicted by leptospirosis on U.S. cattle and swine producers. APHIS's responsibilities to the center are for such regulatory activities as conducting tests for diagnosis and typing and classifying organisms isolated from livestock. The agency will also provide training and diagnostic reagents to state laboratories.

The new center will be based in Ames, Iowa, and involve APHIS's National Veterinary Services Laboratory and ARS's National Animal Disease Center, where leptospirosis has been under study for the past 20 years. ■

This isolating and characterizing is necessary "before we can develop controls," Thiermann says. "The questions spiral from lack of understanding. And controlling the disease in domestic animals may influence the occurrence in man.

"Until now, the United States has not had a reference center capable of characterizing isolates from livestock." (See box, p. 5.)

An advance in isolating leptospires most common in cattle gave researchers a false sense of triumph in the 60's. Ellinghausen and other Center scientists replaced rabbit serum with albumin from bovine serum as a nutrient in the medium for growing leptospires.

"For the first time, we had media that allowed us to isolate organisms reliably from cattle as well as other animals," Thiermann says, "and we could prepare vaccines." The bovine-albumin growing medium and vaccination controlled the problem of leptospirosis in livestock.

With that solution, however, the spiral of questions renewed. "We solved the problem of the very obvious disease-causing leptospires," Thiermann says. "Pomona and grippotyphosa are classic serotypes. When they infect an animal, there's no doubt about it. The animal gets very sick and dies or recovers and that's it.

"Now, however, we have a totally different thing. Here is this little, underground, atypical serotype, which is hardjo. Hardjo was hiding.

"Hardjo affects a few animals at a time. If it causes abortions, it's going to be in one or two animals at a time. It's not a storm. It's not a massive epidemic that you would see with pomona or grippo.

"Hardjo is a more successful cattle parasite than pomona. A successful parasite does not kill its host. Hardjo survives for long times without causing disease, then causes a problem by infecting animals not exposed to it before or animals in poor health.

"It causes losses much more difficult to estimate. It causes infertility, but we don't know that every infertile cow is infected by hardjo.

"So it has been much more difficult to trace," Thiermann continues. "It doesn't like to grow in Ellinghausen's media as easily as the others do.

"Hardjo is still a *Leptospira interrogans,* but some characteristics of this serotype make a difference, which again puts the pressure on USDA and other research centers. I think hardjo is getting close to beating us again."

Hardjo is a special problem in cattle. Thiermann says, "We're seeing hardjo as the true cow-adapted leptospire for the first time."

Livestock and pets can be vaccinated, Thiermann says. Vaccines for hardjo, pomona, canicola, grippotyphosa, and icterohaemorrhagiae are available now.

Most vaccines are "cocktails" or mixtures of different serotypes, and Thiermann says such "cocktails" tend to complicate diagnoses. "You never know whether an animal has antibodies due to vaccination or infection." He points out also that adding another serotype to a mixture dilutes the strength of all. On the other hand, vaccination against one serotype or infection by one and recovery does not protect against others.

The "easy problems in leptospirosis research have been solved," Ellinghausen said in a 1978 review. "The difficult ones remain. Leptospirosis research has come full circle. Our tools will need serious appraisal in the years to come if we are to improve our capabilities in diagnosis."

Alejandro B. Thiermann is located at the National Animal Disease Center, P.O. Box 70, Ames, Iowa 50010.—**Dean Mayberry,** Peoria, Ill. ■

Starch-Held Herbicides Save Money and Soil

Cornstarch compounds that hold herbicides for slow release show promise for reducing tillage operations, cutting farm fuel costs, and reducing soil erosion.

Designed at the Northern Regional Research Center to protect chemicals from the environment and the environment from chemicals, starch compounds that hold herbicides are being tested for weed control in ARS studies at Purdue University. Some of the compounds may prove effective enough to eliminate the need for tillage to work volatile weed killers into the soil.

Marvin M. Schreiber, ARS agronomist, and Michael D. White, research assistant, studied the release of trifluralin, a volatile herbicide, from starch xanthide. Trifluralin protected by the starch compound "had higher herbicidal activity throughout the season than the emulsifiable concentrate regardless of whether the starch formulations were incorporated immediately or left on the soil surface," Schreiber says.

The trifluralin concentrate must be worked into the soil within 4 to 8 hours after it is applied, or it will evaporate or break down in light.

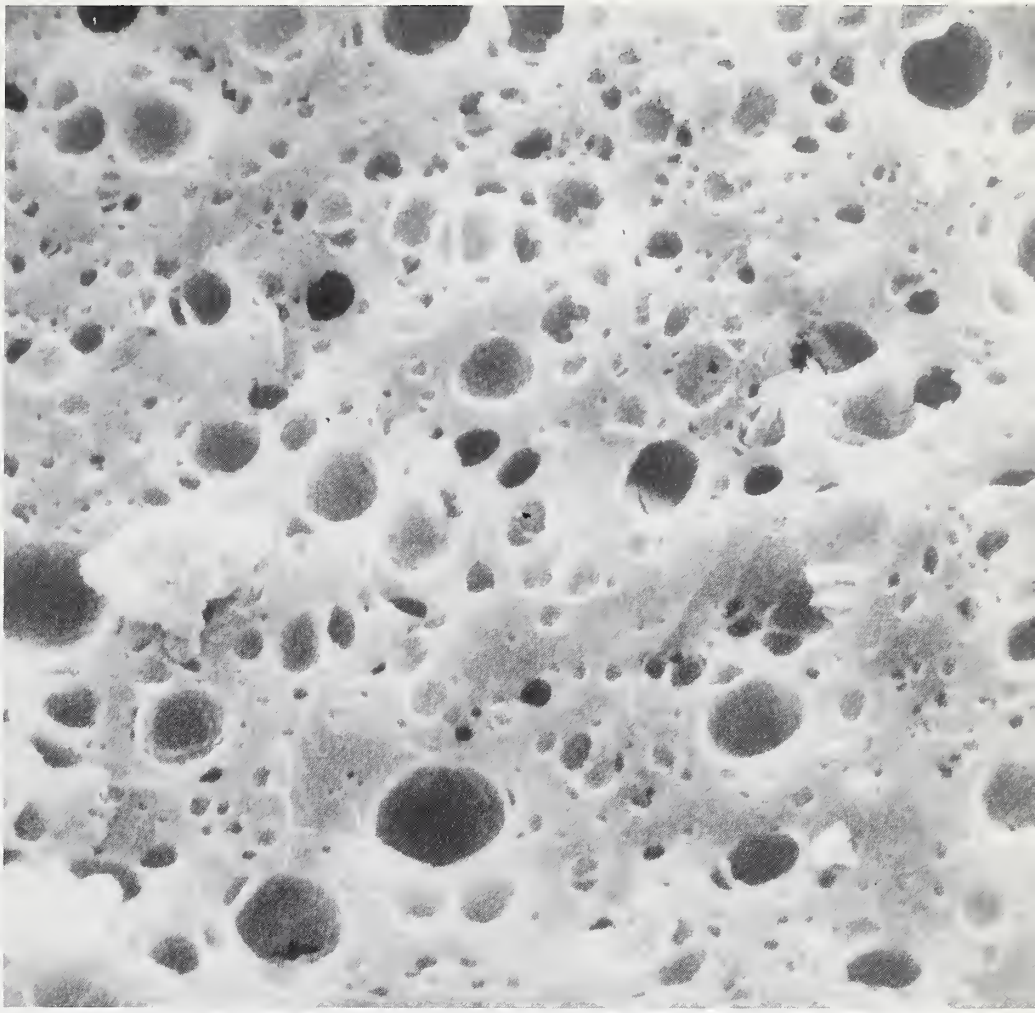
The concentrate "depends upon a high initial dose to compensate for losses," Schreiber says. A starch-held trifluralin, however, "depends upon gradual release." One starch-released formulation reached its highest level of activity 60 days after it was applied in a field test.

In another test, starch-held trifluralin was applied in the fall to control weeds the following spring. Schreiber compared giant foxtail stands in treated and untreated plots to determine effectiveness of weed control.

"The fall surface application was quite remarkable, considering the exposure of these granules to the elements during the winter and the excessive rains that occurred in the spring," Schreiber says.

Starch xanthide, made with carbon disulfide, is one of several compounds designed by Baruch S. Shasha, Donald Trimnell, Robert E. Wing, and Felix H.

Chemist Baruch S. Shasha sieves starch-held herbicide by granule size. (0584X706-12a)



Scanning electron micrograph of a section of starch-held herbicide granule reveals tiny openings or cells that hold the herbicide for slow release. (PN-7098)

Otey, Northern Center chemists. Other starch compounds are made with calcium, barium, strontium, or boric acid.

The compounds are designed to hold herbicides or other chemicals and to release them slowly. They give two kinds of protection says Otey, research leader. They protect chemicals from loss by evaporation, dissolving in water, and destruction by light or soil microorganisms, and they protect people, animals, and nontarget plants from the chemicals.

Starch borate, made with cornstarch and boric acid, is the first of the slow-release starch compounds that holds both water-soluble and non-water-soluble chemicals, Shasha says. In laboratory studies, highly volatile herbicides, such as butylate and EPTC, showed no loss from starch borate when stored several weeks in an open flask.

Making the borate offers chemical companies processing advantages. Otey says making borate "avoids the flammable, toxic carbon disulfide, uses less water than the earlier processes use, and takes less drying."

Starch borate is the first of the compounds to be made on a pilot scale. Otey says the Hopkins Agricultural Chemical Company, Madison, Wis., made 300 to 1,000 pounds of borate holding 60 to 200 pounds of volatile herbicide, such as trifluralin or EPTC, under terms of an agreement with USDA.

Samples of the starch-held herbicides and other chemicals are being tested in ARS and state experiment stations.

Marvin M. Schreiber is located at the Lilly Hall of Life Sciences Bldg., Purdue University, W. Lafayette, Ind. 47907. Felix H. Otey is located at the Northern Regional Research Center, 1815 N. University, Peoria, Ill. 61604.
—**Dean Mayberry,** Peoria, Ill. ■

The Ultimate No-Till System Is a Cow on Grass

Beef cattle grazing on western wheatgrass range in South Dakota. (SD-811)

Just add some good grassland management, plus a little fertilizer and a touch of herbicide now and then, and you have a soil-building program that produces meat efficiently.

That's the soil-conservation philosophy of Russell J. Lorenz, range scientist at the Northern Great Plains Research Center, Mandan, N. Dak., and George A. Rogler, an agronomist who retired in 1973 but is still coming in to work. Between them the two have been working for 79 years on ways to grow more beef on the prairies of the northern Great Plains.

In this period of surplus cereal crop production and increased concern for the nation's topsoil, Lorenz and Rogler see an opportunity to solve several problems by returning marginal cropland to grassland to stabilize erosive soils and by improving grassland management to reduce the cost of livestock production.

Lorenz says there is a tremendous but generally unrecognized potential for range improvement, increased livestock production, and more efficient water use in the semiarid Great Plains and western states through effective fertilizer applications.

"About 75 percent of the land area in the 17 western states is rangeland," he says, "which is more land than the entire area remaining in the other contiguous states. Even though production potential is lower than in more humid areas, the vastness of the western rangelands makes any production increase of great economic importance."

The idea that rangeland should be fertilized is not commonly accepted, Lorenz says. Until results of grassland fertilization studies at Mandan were evaluated, the widely accepted theory was that available soil water was the major factor limiting grass production in the semiarid Great Plains.

Furthermore, Lorenz says, "A fear of upsetting the ecological balance has hindered the acceptance of fertilization as a means of increasing productiveness of grasslands in general and of native range in particular.

"There is some justification for this fear, because under certain conditions there have been rather drastic effects on plant species composition. However, our research produced many examples of favorable changes in species composition when fertilizer was used as a tool in range management and improvement. For example, 2 years of fertilization with 90 pounds of nitrogen each year and continued grazing did more to improve deteriorated mixed prairie range than did 6 years of rest, without grazing."

Even in the first studies beginning in 1944, says Rogler, it became evident that applications of nitrogen on either seeded pastures or native range would greatly increase forage production and water-use efficiency.

Rogler, who started working at Mandan in 1935, set up 10 different renovation treatments in 1949 on crested wheatgrass pastures that had been grazed for 15 years; he then evaluated the treatments for 12 years. Applying nitrogen to undisturbed crested wheatgrass sod proved to be the outstanding renovation treatment, Rogler says. Adding just 30 pounds of nitrogen an acre boosted hay yields 2.5 times over untreated pasture, and 60 pounds yielded 3.7 times as much. Each pound of nitrogen produced an additional 30 pounds of hay for the 30-pound rate and an added 28 pounds of hay at the 60-pound rate.

"The simplest and most economical means of renovation was nitrogen fertilization," Rogler says.

Unfortunately, a weed, fringed sagewort, also responded to the nitrogen. Lorenz, who joined ARS in 1952, added a herbicide treatment to the nitrogen studies. After one herbicide treatment, hay production averaged 995 pounds more an acre each year than untreated pastures over 4 years of measurements.

"Thirty pounds of nitrogen each year, and one herbicide treatment, increased annual yields to 4,745 pounds an acre. Land receiving neither fertilizer nor herbicide averaged 1,795 pounds during the 4-year test," Lorenz says.

Sagewort was not a problem in the unfertilized areas for 2 or 3 years after herbicide treatment; then it started coming back. In the fertilized areas, nitrogen applications prolonged effectiveness of herbicide treatments by causing vigorous grass growth that hindered establishment of sagewort seedlings.

The scientists found results of nitrogen renovation of old pastures so successful that they designed another long-term study for newly established crested wheatgrass pastures using beef gains to measure effectiveness. Treatments were: no nitrogen, 40 pounds a year, 80 pounds a year, and an alfalfa-crested wheatgrass mixture.

Nitrogen was applied each October as ammonium nitrate.

Yearling steers grazed the pastures from May 16 until about July 1, or for as long as it took them to remove the usable forage.

"The 40-pound treatment seemed to be the best," Lorenz says. "In only 2 of the 10 years of the test did beef production from the 80-pound treatment significantly exceed that from the 40-pound treatment." (See graph, this page.)

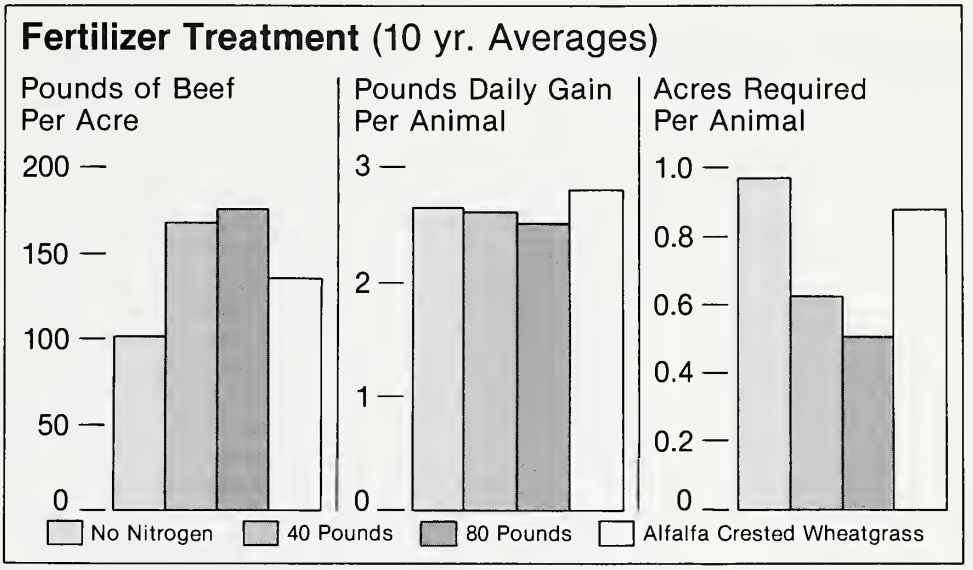
Production from the pasture receiving 40 pounds of nitrogen was 68 percent greater than from pastures receiving no nitrogen, and 25 percent better than the grass-alfalfa mix. From a management standpoint the advantage lies in the increased number of animals per unit of land, not in the increased gain per head, Lorenz says. The carrying capacity of the pasture receiving 40 pounds of nitrogen was 72 percent greater than of that getting no nitrogen. Carrying capacity of the pasture getting no nitrogen fertilizer decreased sharply over the 10 years, while the fertilized pastures remained stable.

"Treating native grassland with nitrogen is more complicated," Rogler says, "because of differences in species and the changes that occur in the mixture of vegetation due to grazing pressure, fertilizer treatment, and other environmental factors.

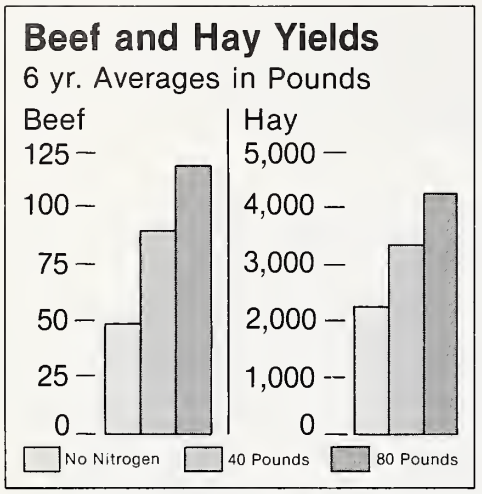
"We compared treatments of 30 and 90 pounds of nitrogen on typical prairie pasture that had been grazed for 35 years. One area had been overgrazed, the other moderately grazed."

Vegetation on the heavily grazed pasture had changed from typically mixed prairie plants to almost pure blue grama. Though yields were extremely low, 30 pounds of nitrogen doubled the yield and 90 pounds more than tripled it. The few remaining western wheatgrass plants recovered quickly and accounted for most of the increase.

"Recovery of the overgrazed prairie was remarkable," Rogler says. "In 4 of the 6 years of the study, yields were highest from fertilized plots in the



Agronomist George Rogler (left) and range agronomist Russell Lorenz inspect a test plot of blue grama grass. (0673W1231-9)



pastures that had been overgrazed."

Much of the response to nitrogen is by cool-season grasses that make their growth early in the season when soil moisture is at its best but nitrification activity is slow.

This study set the stage, Lorenz says, for a 6-year study on native rangeland comparing zero nitrogen and 40 pounds and 80 pounds of ammonium nitrate broadcast in October each year.

Measured in terms of beef production per acre, the results clearly show the great potential of nitrogen application, he says. Averages for the 6 years show the greatest benefits from the 40-pound-per-acre application rate. Hay yields, sampled each August 1 from small caged areas in each pasture and weighed at 12-percent moisture, followed the same trends. (See graph, left.)

"Perhaps one of the more important findings of the study was in relation to water," Lorenz says. "The pounds of forage produced from each inch of water used increased as the nitrogen level increased. In effect, the addition of nitrogen was like adding water, the limiting factor in the semiarid Great Plains."

The simplest and most economical method of fertilizer application on grasslands is to broadcast on the surface, he adds. "We found no benefit from application with a heavy-duty drill."

From the standpoint of long-term conservation of soil and grassland resources, and for the long-term benefit of the farmers and ranchers of the Northern Great Plains, use of the grazing ruminant animal to convert forage and roughage to human food will continue to be the most efficient system on much of the land in the northern Great Plains and western states, Lorenz says. And management systems based on improved technology can increase productivity of these lands and protect the natural resources.

Russell J. Lorenz is located at the Northern Great Plains Research Center, P.O. Box 459, Mandan, N. Dak. 58554.—**Ray Pierce,** Peoria, Ill. ■

A New Grass for the Nontilling Cow

A new western wheatgrass variety, Rodan, has been released by ARS, the USDA's Soil Conservation Service, and the North Dakota State University Experiment Station.

In 58 trials, Rodan averaged 178 pounds per acre more forage than other commonly used western wheatgrass lines.

Rodan is named partly after research agronomist George Rogler, now retired, and partly after Mandan. Rogler made a selection of western wheatgrass seeds from a field near Mandan along the Missouri River bottoms in 1936, a year after he came to work at the research station. Then, over the years, he made selections and intercrosses to develop disease resistance, thick stands, fineness of leaves, and drought tolerance.

In more recent years Reed Barker, research geneticist at the Northern Great Plains Research Center, Mandan, also improved the plant material, identified then as Mandan 456, and arranged evaluation at several locations to see if it was good enough to be released as a variety.

Rodan, a new western wheatgrass, averages 178 pounds per acre more forage than other commonly used western wheatgrasses, and is most productive on coarse-textured soils. (PN-7115)

Barker says Rodan is a dense, sod-forming grass with thinner leaves that are less heavily veined than other western wheatgrasses. It is similar to the Rosana variety in its area of adaptation. However, Rodan is more productive on coarse-textured soils.

The main area for use of Rodan is the western Dakotas and eastern Montana and Wyoming, Barker says. It has moderate to good resistance to the stem rust races now common in the northern Great Plains.

Foundation seed is available from the Soil Conservation Service, Plant Materials Center, Bismarck, N. Dak. 58501, Barker says.—**R.P.** ■

New Insights on Copper Metabolism

New research findings on how certain chemicals affect the body's use of copper point to the importance of adequate copper in the diet. The research may yield clues to maintaining a healthy heart and cardiovascular system.

At the Grand Forks Human Nutrition Research Center, ARS research physician Leslie M. Klevay is studying a class of chemicals called cholesterotropic and cuprotropic—meaning they affect cholesterol and copper levels in the body.

The latest Center study was on a drug, clofibrate, that doctors often use to lower cholesterol concentrations in the blood plasma of humans in hope of reducing the risk of heart attacks. Klevay uses such drugs in research as tools for identifying new aspects of how trace minerals are metabolized. The new knowledge may encourage other researchers to study nutritional aspects of trace-mineral metabolism.

Clofibrate may produce its cholesterol-lowering effect by altering copper metabolism, says Klevay. In his experiments on rats, the drug increased the concentrations of copper in blood plasma and the liver while lowering cholesterol levels in plasma.

"We don't know if all cholesterol-lowering drugs lower the animals' requirement for copper," says Klevay, "but that was the effect of clofibrate. Also, we don't know if copper is absorbed through the intestines more efficiently or whether the drugs block excretion of copper or take copper from the kidney or muscle and put it in the liver."

Pioneering research in which Klevay found a relationship between copper deficiency in animals and high concentrations of plasma cholesterol has been confirmed in studies at five additional independent laboratories.

In one of the latest studies, led by ARS chemists Sheldon Reiser and James C. Smith, Jr., of the Carbohydrate and Trace Minerals Nutrition Laboratories, Beltsville, Md., rats on a low-copper diet developed plasma cholesterol concentrations that were about 60 percent above concentrations in rats fed a control diet. The copper deficiency in these rats was not severe enough to produce anemia, the most commonly recognized telltale sign of deficiency.

Balance and depletion studies with human subjects have led the U.S. National Research Council to suggest that adults should consume at least 2 milligrams of copper per day. Klevay's research and studies led by chemists Wayne R. Wolf and Walter Mertz at the ARS Human Nutrition Research Center, Beltsville, Md., have shown that diets with less than this amount are not uncommon in the United States.

It should be possible to avoid copper deficiency without relying on mineral supplements, says Klevay. And careful menu planning with a wide variety of foods may allow diets to have ample copper without excluding any particular food.

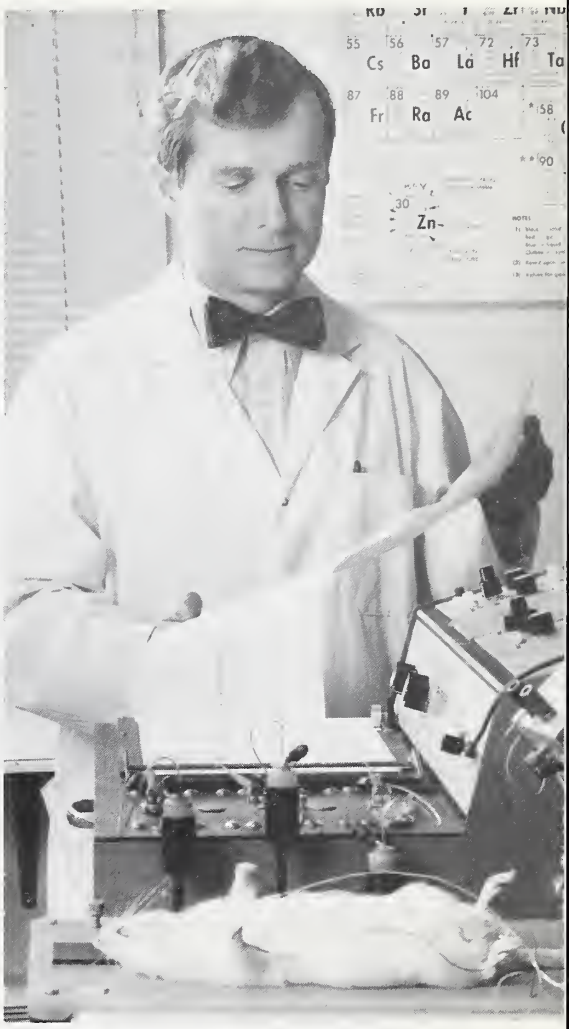
"We know that beef liver, nuts, seeds, and some breakfast cereals contain relatively large amounts of copper," Klevay says. "Most nutrition tables, however, provide dietitians with inadequate information on the amount of copper in various foods and the extent to which this trace mineral can be digested, absorbed, and used by humans."

More information on planning menus adequate in copper will be needed if low consumption of copper in diets is proven to be a public health problem, Klevay says.

In his latest two experiments, Klevay fed laboratory rats low-copper diets with about 500 times as much clofibrate as copper, which is the usual ratio in human therapy.

In the first experiment, diets that contained the clofibrate and 0.4 micrograms of copper per gram of feed led to copper concentrations in the livers that were about 47 percent higher than copper concentrations in rats that did not receive clofibrate. Plasma cholesterol concentrations dropped by about 20 percent in rats receiving clofibrate.

The second experiment confirmed results of the first. In this one the diet contained clofibrate and 0.9 micrograms of copper per gram but was still copper deficient. The concentration of copper in the livers of rats fed this diet increased by 77 percent over concentrations in livers of rats on the control diet. Plasma cholesterol concentrations dropped nearly 30 percent.



Research physician Leslie M. Klevay examines the electrocardiogram of an anesthetized rat to determine the effects of copper-deficiency on the animal. (0484X322-9)

In both experiments, clofibrate administration was associated with higher concentrations of copper in the plasma. These concentrations were 25 percent and 19 percent higher respectively than those of rats on the control diet.

Leslie M. Klevay is located at the Grand Forks Human Nutrition Research Center, P.O. Box 7166, University of North Dakota, University Station, Grand Forks, N. Dak. 58201—**Ben Hardin,** Peoria, Ill.■

New Carrot Excels in Carotene and Flavor

Although most people plant carrot seeds to grow the edible root, horticulturist Clinton E. Peterson (left) and geneticist Phillip W. Simon plant high-vitamin-A carrots to obtain seeds for further experiments. (0584X611-25a)

Carotene, which the human body uses to make vitamin A, is especially abundant in a new flavorful carrot called A Plus.

The new hybrid has about 76 percent more carotene than the variety most widely grown in California. Most commercially grown carrots contain 60 to 90 micrograms of carotene per gram; A Plus has 150 micrograms per gram, says ARS horticulturist Clinton E. Peterson, Madison, Wis.

Plant geneticist Philipp W. Simon, who conducted taste panel and laboratory analyses, estimates that 40 to 60 percent of the carotene in A Plus, as well as of the other hybrids he compared it to, is in the form called beta-carotene. That's the form that is most useful in making vitamin A in the body.

The Recommended Daily Allowance (RDA) of vitamin A for adults is 1,000 micrograms, which could be provided by consuming 6,000 micrograms of beta-carotene. Eating one average-sized A Plus carrot, which contains nearly 15,000 micrograms of carotene, could therefore more than meet the RDA. The RDA for children under 4 is about half this amount.

Fortunately, in addition to its nutritional benefits, the flavor of A Plus was preferred over eight commercial hybrids with which it was compared in taste panel evaluations, says Peterson.

Along with other sources of vitamin A in the diet, carrots high in beta-carotene can be quite helpful from a nutritional perspective, says Harold H. Sandstead, research physician and director of USDA's Human Nutrition Research Center on Aging, Medford, Mass. Insufficient vitamin A intake is a major nutritional problem worldwide.

Is there any danger of carrots providing too much carotene? It doesn't seem likely, says Sandstead. Whereas vitamin A that is contained in fish oils could be toxic if taken in doses that are too large, the carotene in carrots is not toxic.

Consuming large quantities of carrots high in carotene could increase carotene levels in blood plasma to unusually high levels but it would not be harmful, Sandstead says. Extremely large amounts of carotene could contribute toward a harmless yellowing of the skin but it would be a rare individual who might consume a diet with enough high-carotene carrots to cause this condition.

Developed as a fresh-market carrot, A Plus is adapted for production in both organic and mineral soils where Imperator 58, Gold Pak, and Orlando Gold are grown. The Florida, California, and Idaho Agricultural Experiment Stations worked with ARS to develop the hybrid.

Several hundred acres of commercial trials in 1984 will provide enough A Plus carrots to test consumer acceptance, Peterson says.

A Plus is a breeding advance over the carrot hybrid, Orlando Gold, that was developed about 2 years earlier. Orlando Gold's carotene content is only about 50 percent more than that of the most widely grown variety in California. An industry spokesman has said the development of Orlando Gold is of sufficient value to pay for all previous research that has gone into carrot breeding.

With sophisticated advances in laboratory analyses that contribute to economical breeding efforts, consumers may expect further rapid increases in carotene content and flavor quality in future hybrids, says Peterson. Some individual carrots from continuing breeding efforts have produced about 4 times as much carotene as that found in most currently used varieties.

Clinton E. Peterson is located in the Department of Agronomy/Horticulture, University of Wisconsin, Madison, Wis. 53706.—**Ben Hardin,** Peoria, Ill. ■

Foiling the Finicky Grasshopper

Grasshoppers are gourmets when it comes to selecting plants for food, but being finicky could backfire on them.

According to entomologist George B. Hewitt, some grasses on western ranges appeal less than others to grasshoppers. Yet, these plant-eating insects were thought to have a hearty appetite for all grasses.

Hewitt says unappealing plants such as alfalfa are prime candidates for keeping fragile western grazing land covered for foraging livestock and for erosion control.

Grasshoppers annually infest most of the 650 million acres of rangeland west of the Mississippi. In 17 of 22 western states, they destroy about 23 percent of the forage suitable for grazing livestock—about a $403 million yearly loss.

Hewitt has been evaluating plant preferences of grasshoppers in laboratory and field tests at Bozeman, Mont.

What Hewitt found was that, of the 15 types of plants tested, alfalfa was least preferred by grasshoppers. Trefoil and cicer milkvetch were next on the least-liked list.

Hewitt identified grasshopper preferences by measuring the insects' growth and weight gains after feedings, as well as by observing the amount of time grasshoppers spent eating plants during a 30-minute period, whether plants survived after being eaten, and the percent of leaf reduction.

George B. Hewitt is located at the Rangeland Insect Laboratory, Montana State University, S. 11th Ave., Bozeman, Mont. 59717.—**Henry Becker,** Beltsville, Md. ■

Grasshopper on a Montana range plant. (0779X981-18a)

Making Range Grasses Unpalatable to Insects

Do insects that feed on grass plants have preferences within species of plants they feed on? Can we identify the chemicals causing the insects to prefer one grass over another? Could we screen for these chemicals in the development of new grass varieties?

These and other questions are being explored by ARS researchers along with researchers from the Utah State University (USU) at Logan, in a new approach to breeding insect resistance into rangeland grasses.

Each year, extensive damage is inflicted on range grasses by insects such as the black grass bug *(Labops hesperius* and *Irbisia pacifica)* and the bluegrass billbug *(Sphenophorus parvulus).* Pesticides can be effective against these pests, but application costs on western rangeland are prohibitive.

Scientists traditionally have chosen plants for grass-breeding programs based on the plants' ability to withstand attack rather than on their resistance to it.

ARS and USU researchers are seeking instead to find truly resistant germplasm in order to develop plants that the insects won't bother. In recent studies they have shown that insects do indeed display a preference for some grass varieties over others, and in the case of the black grass bug, have already identified two chemicals they can link to the preference.

Conducting these ongoing studies are ARS geneticist Kay H. Asay, entomologist James D. Hansen, and USU entomologist B. Austin Haws, all at Logan, with cooperation from Patrick O. Currie, an ARS range scientist at Miles City, Mont.

According to Asay, if the chemicals that grass-feeding insects prefer can be identified, resistant plants might then be identified on the basis of their chemical constitution.

Problems will be posed if the chemicals responsible for insect preference prove to be the same chemicals responsible for plant quality factors. If so, decisions will have to be made weighing the benefits versus the drawbacks of removing these chemicals from new plant varieties. In the ARS-USU tests so far, grass variety preferences of cattle and insects do seem to coincide.

As an alternative, Asay suggests that if there is a chemical source of preference, there might also exist chemical sources of resistance that would repel insects from a plant.

Says Asay, "If we could identify chemicals associated with resistance, perhaps we could incorporate these chemicals into a crossing program, adding a resistant characteristic that breeders could select for."

Another approach might be to determine if there are other species for possible use on rangeland that insects find less palatable (see box).

Early evidence from tests on the bluegrass billbug, a turf insect, indicates that grass selection for resistance is possible and would be effective, though the source of resistance will be difficult to determine. However, billbugs are weevils, and they feed by chewing on stems and roots rather than sucking on leaves like black grass bugs. Whether a chemical source of resistance would apply to both insects is not known.

Kay H. Asay and James D. Hansen are located at the Crops Research Laboratory, UMC 63, Utah State University, Logan, Utah 84322.—**Lynn Yarris,** Oakland, Calif. ■

Advantages of Planting Mixed Wheat Varieties

Mixtures of soft white spring wheat varieties with a wide range in potential yield, milling, and baking properties illustrate the ancient aphorism that the whole is often greater than the sum of its parts.

Tests conducted by agronomist Allan J. Ciha and food technologists Gordon L. Rubenthaler and Herbert C. Jeffers, Pullman, Wash., have shown that mixing different spring wheats offers growers the advantages of each individual variety's strengths while compensating for each variety's weaknesses. This practice would help stabilize yields against diverse climatic conditions and diseases.

Much research has already been done on the yield response when varieties are mixed, but little has been done to examine the effects on the processing properties of the harvested grain.

The commercial wheats the research team studied were Fielder and Urquie, both known to have good milling and baking properties; Twin, known to have fair processing properties; and World Seeds-1(WS-1), an exceptionally high-yielding wheat with poor processing properties.

When the higher quality varieties were mixed with WS-1, the flour yield, protein level, dough-mixing characteristics, and baking properties of the harvested grain were substantially better than the processing qualities of grain from pure stands of WS-1. In fact, they were close to the quality of pure stands of Urquie, Fielder, and Twin. Low test weights and high flour ash content, however, made the WS-1 combinations with Twin less desirable than the combinations with Urquie and Fielder.

Planting dates were found to have little or no effect on the processing properties of any of the stands tested, but delaying the planting date significantly reduced grain yields and test weights for all mixtures, the researchers report.

Pure stands of the four varieties planted on three different dates averaged 1.9 tons per acre for WS-1, 1.7 tons per acre for Urquie, and 1.6 tons per acre for Twin and Fielder over 3 years. What the ARS researchers found was that combinations of the latter three varieties with WS-1 did not show reduced grain yield compared to pure stands of WS-1 until more than 50 percent of the mixture was Twin or Fielder or more than 75 percent of the mixture was Urquie.

Wheat harvest near Pullman, Wash. (0983X1265-33a)

Allan J. Ciha is located at Johnson Hall, Rm. 209, Washington State University, Pullman, Wash. 99164. Gordon Rubenthaler and Herbert Jeffers are located at the Western Wheat Quality Laboratory, Rm. 7, Wilson Hall, Washington State University, Pullman, Wash. 99164.—**Lynn Yarris,** Oakland, Calif. ■

Tinkering With Insects' Bio-Clocks

Future pesticides may control insects by tinkering with their biological clocks.

"If we can isolate those chemicals in the brains of insects that start their biological reactions, we can use these chemicals to biologically control insects," says biochemist Dora K. Hayes. "For example, unwanted insects might be stimulated to develop into adults during the winter, when food supplies are scarce.

"One important factor in insect development is the length of daylight," Hayes says. "Lengths of 14 to 16 hours encourage some insects to develop further, while 13 hours or less may force them into winter hibernation."

Environmental signals, like light, start a series of biochemical reactions. The brain receives these signals and produces hormones that control the levels of other hormones, like ecdysone and juvenile-growth hormones, that regulate insect development.

Hayes and colleagues at Beltsville, Md., are studying the hormones produced in the brain of face flies, an important pest affecting livestock. By comparing the chemicals from hibernating insects with those still developing, Hayes hopes to find the controlling hormones.

Understanding development cycles is also important in timing the release of sterile male insects for pest control and for applying other pest control treatments at the most effective time," she says.

Dora K. Hayes is located at the Livestock Insects Laboratory, Bldg. 307, Beltsville Agricultural Research Center-East, Beltsville, Md. 20705.—**Henry Becker,** Beltsville, Md. ■

Improving USLE for Grazing Management

Grazing management decisions based on erosion predictions drawn from use of the Universal Soil Loss Equation (USLE) apparently have ample room for improvement.

Using a rotating-boom rainfall simulator, ARS researchers in Boise, Idaho, were able to measure soil losses on a variety of rangeland sites and compare these measurements to erosion estimates made for the same sites using the USLE. The results showed the equation consistently overestimating soil losses by about 20 percent.

In order to control erosion, federal and state land management agencies have been using the USLE as a basis

for telling livestock owners when to stop their animals from grazing rangeland. The equation has stood the test of time as an accurate means of forecasting soil losses from cultivated areas. However, the USLE has never been validated on sagebrush rangelands.

Hydraulic engineer Clifton W. Johnson led a study to compare erosion on grazed and ungrazed rangeland and to evaluate the merit of soil loss estimates made for these lands using the USLE.

Says Johnson, "Greater surface vegetation and the absence of cattle disturbing the soil's surface helped hold erosion losses on ungrazed areas down to as little as a third of the losses suffered on grazed areas. However, neither grazed nor ungrazed areas showed as much soil loss as we would have seen on agricultural lands under similar conditions."

Johnson's study was conducted on four sites representing sagebrush rangeland soil and cover conditions in southwest Idaho and northern Nevada.

Johnson says, "The natural roughness and depression storage of these rangelands, in addition to vegetative cover and root mass, increase the soil's ability to store water and does much to keep soil loss in check."

Johnson, along with ARS hydraulic engineer Kenneth G. Renard, Tucson, Ariz., and others, is continuing to collect the data that will be needed to more accurately apply the USLE to rangelands.

Clifton W. Johnson is located at Patti Plaza, Suite 116, 1175 S. Orchard, Boise, Idaho 83705.—**Lynn Yarris,** Oakland, Calif. ■

Partial Sterility
a New Pest Control Method

Partially sterilizing male insect pests before releasing them to mate in wild populations is emerging as a new method of pest control.

Just enough gamma radiation is used on males to damage chromosomes, perhaps just a quarter of the dosage that would fully sterilize them and reduce their ability to compete with normal males for mates, says entomologist James E. Carpenter.

Carpenter and coworkers found in experiments at the Grain Insects Laboratory, Tifton, Ga., that these treated males can mate successfully and pass the genetic damage to their offspring.

Reduction of pest populations from this genetic damage reaches full expression in the third or fourth generation, Carpenter says.

During the first three generations, most of the insect pests inheriting these defects fail to survive to maturity and pest populations dwindle.

The relatively few insects that survive to the fifth generation are largely purged of the bad effects from the radiation, Carpenter says. At this point, populations rebound and a new round of treatment may be necessary.

Carpenter has tested the technique on some of U.S. agriculture's most serious pests, the fall armyworm and corn earworm. These pests attack corn, cotton, sorghum, and other crops, causing annual damage estimated at $500 million.

Partial sterility is also effective with less mobile pests, such as stored product insects, the European corn borer, and the gypsy moth.

According to Carpenter, radiation damage affects the numbers of eggs laid and hatched, the physiological ability to go through metamorphosis, and such behavioral traits as competition for mates. The extent of these effects depends on the amount of radiation received by the insect.

In his research, the entomologist used a model to simulate release of nine times as many treated fall armyworm moths as were estimated to exist in the local wild population. Carpenter concluded that partial sterility could be five to seven times more effective than complete sterility in controlling fall armyworms.

James E. Carpenter is located at the Georgia Coastal Plains Experiment Station, Tifton, Ga. 31793.—**Margaret Adams,** Beltsville, Md. ■

Controlling Black Nightshade

"Control eastern black nightshade until late June when a good stand of soybeans is established, and it will not be a serious problem in the northern Corn Belt," says weed scientist Robert N. Andersen.

On test plots at Rosemount and St. Paul, Minn., Andersen and University of Minnesota graduate student Laura S. Quakenbush conducted 2 years of tests to determine the effect soybean interference has on late seed emergence and berry production of eastern black nightshade *(Solanum ptycanthum* Dun.).

They found that, when grown without soybean interference, eastern black nightshade planted in May produced as many as 7,000 berries and 800,000 seeds per plant. Those planted as late as mid-July produced as many as 100 berries, while those planted in mid-August produced none.

When planted in competition with soybeans in May, nightshade produced fewer than 85 berries per plant. Three or fewer berries were produced when planted in June, and no berries resulted from July planting.

However, when soybeans were defoliated in July to simulate hail injury, eastern black nightshade planted with soybeans in May produced up to 1,600 berries per plant, and those planted into defoliated soybeans in July produced up to 58 berries per plant.

"Our research results show that, when competing with soybeans, eastern black nightshade emergence and survival is greatly reduced when the soybean canopy begins to close. Even those that do emerge late and survive remain quite small and would not significantly affect harvest," Andersen says.

Eastern black nightshade, the most troublesome of four nightshade species occurring as weeds in North America, infests about 5 percent of Midwest soybean acreage throughout the Corn Belt and into adjacent states. It is an increasingly important problem, he says. Nightshade can reduce yields and cause machinery problems at harvest. Berries can stain the beans, and, if stored with soybeans, can provide the moisture that favors mold.

Robert N. Andersen is located in Rm. 404, Agronomy Bldg., 1509 Gortner Ave., St. Paul, Minn. 55108.—**Gordon Joyner,** Peoria, Ill. ■

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This male tobacco budworm moth is dispersing pheromones, or scent molecules, into the air through structures called hairpencils. The pheromone was recently identified by ARS chemist Martin Jacobson and entomologists Victor E. Adler and Alfred H. Baumhover.

According to Jacobson, the pheromone produced by the male tobacco budworm *(Heliothis virescens)* is actually a trace constituent of the female's sex pheromone, hers being a mix of seven chemicals that she disperses to call a mate.

However, the male produces 1 million times more of his pheromone than the female does, so he effectively jams her calling signal once he reaches her, Jacobson says. But if the female rejects the male during his courtship dance, which does occasionally happen, he stops dispensing his pheromone and flies away, giving the next suitor a chance.

The newly identified pheromone has potential for field use to interfere with the courtship flight of competing males and thus reduce the number of matings. It should also be of value to researchers studying how insects use chemical codes to bring about specific behavior.—**Russell P. Kaniuka,** Beltsville, Md. ■

(0484X472-34a)